MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

EEE3096 – COMMUNICATION ELECTRONICS
(TE)

23th OCTOBER 2018
9:00 A.M. 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with 4 Questions only.
2. Attempt **ALL FOUR** questions.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) A typical system employing attenuator has four parameters that are of interest. List out these four parameters.

[4 marks]

(b) With the aids of circuit diagram, list out three types of attenuators.

[6 marks]

(c) Determine the 3 dB bandwidth of the two circuits shown in Fig. Q1c, both before and after adding a 2 μH inductor in series. Sketch and compare the impedance frequency response results for both circuits. Comment on the differences in terms of the bandwidth and the selectivity.

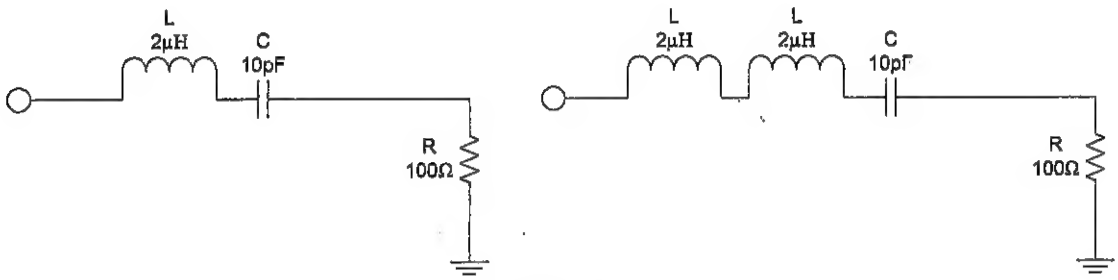

Fig. Q1c

[7 marks]

(d) Design an impedance matching using L-network for a circuit with the source impedance $R_S = 200\ \Omega$ and the load impedance, $R_L = 400\ \Omega$, $X_L = 0$ at a frequency of 100 MHz. Sketch and label all the values for each component of the network.

[8 marks]

Question 2

(a) Draw the frequency response for the tuned and untuned amplifier.

[3 marks]

(b) With the aids of suitable diagrams, explain two methods of neutralization.

[4 + 4 marks]

Continued ....

(c) The transistor in Figure Q2c has the following parameters: $r_{bb'} = 50\ \Omega$, $h_{fe} = 200$, $V_A = 50$ V, $C_c = 12$ pF, $f_T = 250$ MHz and $V_{BE} = 0.7$ V. The amplifier is designed to operate at 10 MHz with an operating bandwidth of 1 MHz. The transistor is biased at $I_C = 5\text{mA}$, $V_{CE} = 0.8\ V_{CC}$ and $I_{Rb1} = 0.1 I_C$.

(i) Determine g_m, $r_{b'e}$, r_{ce}, C_e, R_o *and* C_T

[8 marks]

(ii) Determine the value of the inductance L and the capacitance C of the tank network.

[6 marks]

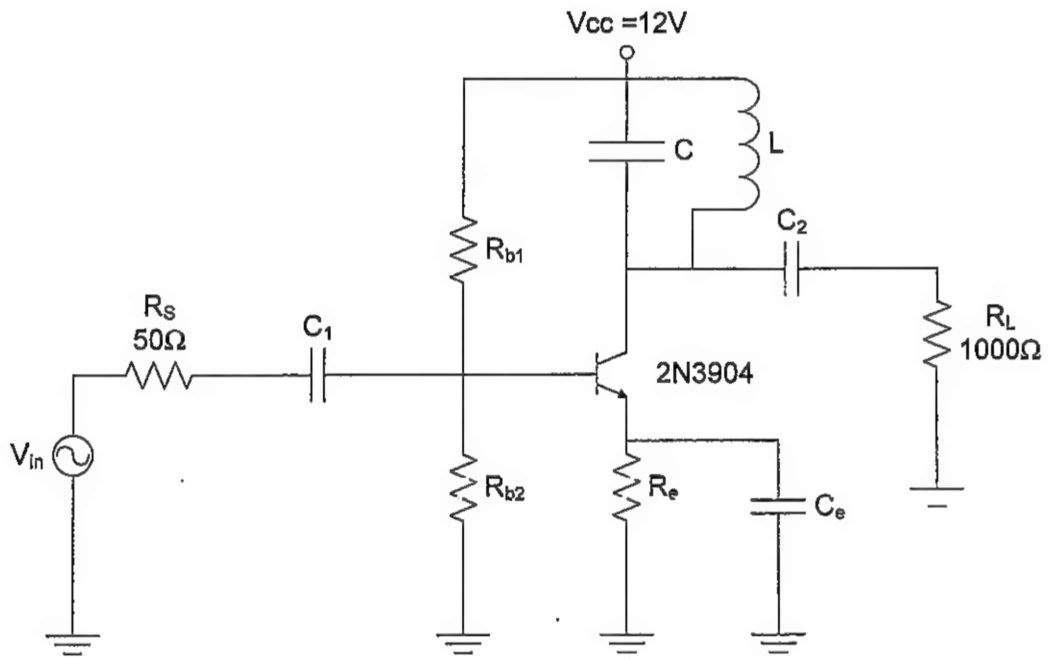

Fig. Q2c

Continued ....

Question 3

(a) Sketch the block diagram of a Phase lock loop (PLL) and briefly explain the functions for each components of the PLL.

[4 + 8 marks]

(b) A PLL with a voltage controlled oscillator (VCO) free-running frequency of 5 MHz has a 15 % capture range and a 30 % lock range. Over what frequency will the PLL able to capture and subsequently maintain lock?

[4 marks]

(c) Design a PLL frequency synthesizer that will cover a frequency range of 144 to 148 MHz in 5-kHz steps, starting at 144 MHz. Assume that the reference oscillator frequency is 5 MHz, the frequency divider is fixed at M value, and the programmable frequency divider has N value, so that the synthesizer will cover the desired range.

(i) Sketch a diagram of your PLL frequency synthesizer design, showing the frequencies present at various points of the diagram.

[4 marks]

(ii) Determine the value N of the programmable frequency divider.

[5 marks]

Question 4

(a) Sketch the block diagram of a black and white television (TV) receiver.

[9 marks]

(b) Explain the basic working principle of gated automatic gain control (AGC). Explain why gated AGC is preferred over AGC using averaging or peak detector in television (TV) receivers.

[6 marks]

(c) Give the pros and cons for Amplitude Modulation (AM) in transmitting a TV signal.

[6 marks]

(d) Given that National Television System Committee (NTSC) defines a frame rate of 30 fps with 525 lines per frame. Determine the field and line frequency.

[4 marks]

Continued ....

Appendix – Useful Formulas

1. L impedance matching network (when $R_L > R_S$):

$$B = \frac{X_L \pm \sqrt{R_L / R_s}\sqrt{R_L^2 + X_L^2 - R_s R_L}}{R_L^2 + X_L^2} \qquad X = \frac{1}{B} + \frac{X_L R_s}{R_L} - \frac{R_s}{B R_L}$$

$$Q = \frac{|X|}{R_S}$$

2. L impedance matching network (when $R_L < R_S$):

$$B = \pm\frac{\sqrt{(R_s - R_L)/R_L}}{R_s} \qquad X = \pm\sqrt{R_L(R_s - R_L)} - X_L \qquad Q = R_S|B|$$

3. π impedance matching network:

$$L = L_1 + L_2 = \frac{R_I}{\omega_o}\left(\sqrt{R_S / R_I - 1} + \sqrt{R_L / R_I - 1}\right)$$

$$C_1 = \frac{1}{\omega_o R_S}\sqrt{\frac{R_S}{R_I} - 1} \qquad C_2 = \frac{1}{\omega_o R_L}\sqrt{\frac{R_L}{R_I} - 1} \qquad Q = \sqrt{\frac{R_S}{R_I} - 1} + \sqrt{\frac{R_L}{R_I} - 1}$$

4. RF Class A transistor amplifier (Hybrid π model of BJT)

$r_{bb'}$	**The base-spreading resistance.**
g_m	**The transconductance.** $g_m = \frac{dI_C}{dV_{BE}} = \frac{qI_C}{kT} \cong \frac{I_C(\text{in mA})}{25.875mV}$ at T=300K, q= electronic charge, 1.6×10^{-19}C
C_e	**The emitter capacitance.**
$r_{b'e}$	**The input resistance.** $r_{b'e} = \frac{dV_{B'E}}{dI_B} = \frac{h_{fe}}{g_m}$
$r_{b'c}$	**The collector to base resistance.** $r_{b'c} = h_{fe} r_{ce}$
C_C	**The collector capacitance.**
r_{ce}	**The output resistance.** $r_{ce} \cong \frac{V_A}{I_C} = \frac{qV_A}{kTg_m}$ Where V_A is known as the Early voltage and I_C is the dc collector current.

Continued ....

5. High frequency Class A amplifier parameters:

(a) Voltage gain:

$$A_V = \frac{v_o}{v_{BE}} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + r_{b'e}} \frac{1}{1 + j\omega C_T \dfrac{r_{bb'} r_{b'e}}{r_{bb'} + r_{b'e}}}$$

In cases where $r_{bb'} << r_{b'e}$ then

$$A_V = \frac{v_o}{v_{BE}} = -\frac{g_m R_o}{1 + j\varpi C_T r_{bb'}}$$

(b) Effective voltage gain (including the effect of source impedance R_S):

$$A_{VS} = \frac{v_o}{V_S} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + R_S + r_{b'e}} \frac{1}{1 + j\omega C_T \dfrac{(R_S + r_{bb'}) r_{b'e}}{R_S + r_{bb'} + r_{b'e}}}$$

In cases where $(R_s + r_{bb'}) << r_{b'e}$ then

$$A_{VS} = \frac{v_o}{V_S} = -\frac{g_m R_o}{1 + j\varpi C_T (R_S + r_{bb'})}$$

Where $C_T = C_e + C_M$ and C_M = Miller capacitance $C_M = (1 + g_m R_o) C_C$

(c) Transition frequency

$$f_T = \frac{1}{2\pi} \frac{g_m}{C_e + C_C}$$

(d) Input impedance

$$Z_I = r_{bb'} + \frac{r_{b'e}}{1 + j\omega r_{b'e} C_T}$$

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